

## Claims

1. A method for determining at least one time constant of a reference model, which is designed as a 2nd order time-delay element and is arranged in a cascaded control arrangement of a machine between a position control device with a loop gain and a speed control device, which comprises a proportional branch and an integral branch, and wherein the reference model at least essentially simulates the behavior of the closed speed control circuit without taking the integral portion into consideration,

characterized in that

an optimized value ( $T2\_OPT$ ) of a time constant ( $T2$ ) of the reference model is determined as a function of a detected oscillation frequency ( $f_{s1}$ ,  $f_{s2}$ ) of an undamped machine oscillation.

2. The method in accordance with claim 1, characterized in that

- starting values  $T1\_01$ ,  $T2\_01$  are preset for the two time constants ( $T1$ ,  $T2$ ) of the reference model,

- subsequently the loop gain ( $kV$ ) of the position control device is increased in steps up to a first maximum loop gain ( $kV_{max1}$ ), at which an undamped machine oscillation can be registered,

- the oscillation frequency ( $f_{s1}$ ) of the undamped machine oscillation is determined,

- the optimized value of a time constant ( $T2\_OPT$ ) is determined as a function of the oscillation frequency ( $f_{s1}$ ).

3. The method in accordance with claim 2, characterized in that the starting values for the time constants ( $T1$ ,  $T2$ ) are preset in accordance with  $T1\_01 = 0$ ,  $T2\_01 = 0$ .

4. The method in accordance with claim 2, characterized in that the optimized value of the second time constant ( $T2\_OPT$ ) is determined in accordance with the equation

$$T2\_OPT = f(f_{s1}) = 1 / (2 * \pi * f_{s1}).$$

5. The method in accordance with claim 1, characterized in that the other, first time constant ( $T1$ ) of the reference model is determined from preset system parameters.

6. The method in accordance with claim 5, characterized in that the other, first time constant ( $T1$ ) of the reference model is determined in accordance with the equation

$$T1\_OPT = (J_L * 2 * \pi) / (k_p * K_{MC})$$

wherein  $J_L$ : Momentary load,

$k_p$ : Loop gain of the proportional branch of the  
speed control device,

$K_{MC}$ : Motor constant.

7. The method in accordance with claim 5, characterized in that subsequently a check is performed whether the previously determined time constant ( $T1\_OPT$ ,  $T2\_OPT$ ) of the reference model assures the desired control behavior of the control arrangement.

8. The method in accordance with claim 7, characterized in that for this purpose the loop gain ( $kV$ ) is increased, using the optimized time constant ( $T1\_OPT$ ,  $T2\_OPT$ ), until an undamped machine oscillation can be registered, and the associated loop gain is used as the second maximum loop gain ( $kV_{max2}$ ) during the subsequent control operation.

9. The method in accordance with claim 8, characterized in that the determined second maximum loop gain ( $kV_{max2}$ ) is multiplied by a safety factor  $K$  for use in the control operation, wherein  $K < 1$ .

10. The method in accordance with claim 5, characterized in that thereafter a check is performed whether the selected first time constant ( $T1\_OPT$ ) provides an acceptable system behavior, or whether an optimization of the first time constant ( $T1$ ) must be performed.

11. The method in accordance with claim 10, characterized in that in case of a required optimization of the first time constant ( $T1$ ), proceeding from a preset starting value ( $T1\_02$ ) for the first time constant the first time constant ( $T1$ ) is changed in steps until an undamped machine oscillation can be registered, and the value of the first time constant ( $T1$ ) obtained therefrom is used as the optimized value ( $T1\_OPT$ ) for parameterizing the reference model.

12. The method in accordance with claim 11, characterized in that, using the optimized second time constant ( $T2\_OPT$ ) and the actual first time constant ( $T1$ ), the loop gain ( $kV$ ) is increased until an undamped machine oscillation can be registered, and the associated loop gain is used as the second maximum loop gain ( $kV_{max2}$ ) in the subsequent control operation.

13. The method in accordance with one of the preceding claims, characterized in that the method can be exercised in an automated manner.

14. Use of a reference model, which had been parameterized in accordance with one of the previous claims, in a cascaded control arrangement of a machine, wherein the reference model (40) is arranged between a position control device (10) and a speed control device (20).

15. Use of a reference model, which had been parameterized in accordance with one of the previous claims, in a cascaded control arrangement of a machine, wherein the reference model (40) is arranged between a position control device (10) and a speed control device (20) and wherein the machine would theoretically require an nth order reference model, wherein  $n > 2$  applies.

16. A device, characterized in that it is suitable for executing a method in accordance with one of claims 1 to 15.